HEATSINK ASSEMBLY HAVING STABILIZATION PLATE

FIELD OF THE INVENTION

This invention relates to a heatsink, and is more specifically related to a heatsink applied in an apparatus such as a liquid crystal display or a server.

BACKGROUND OF THE INVENTION

FIG. 1 is schematic, cross-sectional view of a conventional heatsink and a die cooled with the heatsink. Referring to FIG. 1, a thermal pad 102, is disposed on the contact between the bottom of the heatsink 104 and the die 100, it generally serves as a medium for conducting the heat from the die 100 to the heatsink 104. Usually, the gravity center of a conventional heatsink 104 is located on its right portion, because the right cooling fins 104b are often more than the left cooling fins 104a. The left portion of the heatsink 104 is not extended due to the space consideration. That is, a power supply is designed to be disposed on the heatsink's right side. Therefore, if a skilled person wants to increase the efficiency of heat dissipation, they usually increase the right cooling fins 104b and, simultaneously moves the gravity center further right. When fastening such a center-biased heatsink 104 onto a socket, torque is generated on the left side of the gravity center (since the fastening point is not centralized onto the gravity center). The torque is the reason why the thermal pad 102 could not closely make

contact with the die 100. Without close contact, the heat from the die 100 cannot be transferred to the thermal pad 102 smoothly.

Still referring to FIG. 1, when the torque creates the deviation, only the left portion of the thermal pad 102 contact onto the die 100. In this case, the same heat is transferred through only the small contact area. In other words, the heat density on the contact area is quite high (If the same heat could be transferred through the whole thermal pad 102, the heat density would be lowered). In the case that the included heat is about 31.5 W or 29.5 W, the temperature of the die will continuously be increased to go beyond the tolerable fabrication specification of a CPU manufacture. See the following formula:

$$W = KA\frac{\Delta T}{\Delta X}$$

wherein K is heat conduction coefficient; A is contact area; ΔT is temperature increase; and ΔX is the thickness of the heatsink.

Based on the formula, if the contact area A is reduced, the same heat would dramatically increase the temperature, since the K and the ΔX is constant. Referring to FIG. 1 as an example, in which the contact area is reduced to be a half of the original, the temperature increase ΔT may be too great to be within the tolerable fabrication specification of a CPU manufacture.

In fact, a heatsink manufacture usually adopts the temperature standard requirement concluded by the CPU manufacture. Therefore, if violation of the standard requirement is merely caused by a thermal pad's weak contact, it is more a loss than gain.

SUMMARY OF THE INVENTION

A purpose of the invention is to remedy the problem of the heat conduction between a heatsink and a die. Therefore, in this invention, a stabilization plate is added on the heatsink's surrounding. The stabilization plate makes the heatsink stick well on the die, thereby the heatsink can efficiently dissipate the heat from the die.

According to a preferred embodiment of the present invention, the stabilization plate can be made of heat-resistant PORON, coated with paste thereon. The stabilization plate is preferably slightly thinner than the die; such design makes the heatsink well contacted onto the die. Experiments show that the temperature of the die is decreased and it becomes stabilized with the use of the stabilization plate.

In another aspect, this invention provides a cooling assembly. The cooling assembly comprises an n-shaped PORON slice and a heatsink stuck with the n-shaped PORON slice.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is schematic, cross-sectional view of a conventional heatsink and a die cooled with the heatsink;

FIG. 2 is a schematic and three-dimensional view of a heatsink stabilization plate according to a preferred embodiment of the present invention;

FIG. 3 is a schematic, cross-sectional view of a stabilization plate, a heatsink and a die according to one preferred embodiment of this invention;

FIG. 4 is a schematic view of a thick stabilization plate, a heatsink and a die;

FIG. 5 is a schematic view of a stabilization plate having a thickness approximately equal to that of a die; and

FIG. 6 is a schematic, top view of an n-shaped PORON slice according to one preferred embodiment of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 2 is a schematic and three-dimensional view of a heatsink stabilization plate according to a preferred embodiment of the present invention. In general, solid molecules could not completely fill all vacant space between objects such as heatsink 204 and a die. The unfilled vacant space, therefore, needs to be filled with a thermal pad 202. Preferably, the thermal pad 202 is disposed on the contact between the bottom of the heatsink 204 and the die. In this way the thermal pad 202 serves as a medium for heat conduction. Through such a medium, heat is transferred in a surface-to-surface mode instead of a point-to-point mode. To closely stick the thermal pad 202 on the die, a clip (not shown) is added to fasten the die onto a socket thereunder. However, note that the right portion of the heatsink 204 has cooling fins 204a more than the cooling fins 204b of the left portion of the heatsink 204. This difference makes the gravity center of the heatsink located on its right portion. The gravity's center generates torque when the clip is used to fasten the die onto the socket, and the torque is usually a reason why thermal pad 202 cannot closely contact with the die. Without close contact, heat conduction from the die to the thermal pad 202 cannot be performed effectively.

Accordingly, in the present invention, an n-shaped stabilization plate 208 is stuck on the surrounding of the thermal pad 202. By the stabilization of the plate 208, the heatsink 204 is firmly fastened on the die. More technically, the n-shaped stabilization plate compensates the deviation stemmed from the torque. If the left portion of the heatsink

204 bears greater fastening pressure, the left portion 208a of the n-shaped stabilization plate 208 provides more buffer room to the fastening pressure.

The n-shaped stabilization plate 208 is preferably an n-shaped PORON slice coated with an small amount of paste. With the paste, the n-shaped PORON slice is stuck on the 204. Here, the so-called PORON can be a material having a part number 4716 and being fabricated by Rogers, E. Woodstock, Conn., U.S.

FIG. 3 is a schematic, cross-sectional view of a stabilization plate 308, a heatsink 304 and a die 300 according to one preferred embodiment of this invention. In the figure, omission of a thermal pad under the heatsink 304 is merely for the convenience of describing. According to FIG. 3, the space between the heatsink 304 and the chip 301 is reduced by the stabilization plate 308, this space reduction is also a reason why the stabilization plate 308 can provide a buffer to the fastening pressure. On the other hand, when the heatsink 304 is located on the die 300, a slight inclination may be generated. Besides that, during the in-line combination of the heatsink 304 with the die 300, such an inclination is unavoidable. In these cases, the stabilization plate 308 timely reminds an operator of the presence of the inclination, and the operator can correct the combination deviations immediately.

However, it should be noted that the stabilization plate 308 cannot be too thick, since a thick stabilization plate may make the thermal pad and the die separate. A thick stabilization plate 408, a heatsink 304 and a die are schematically shown in FIG. 4. In contrast, FIG. 5 schematically shows a stabilization plate 508 having a thickness approximately equal to that of the die 300. In FIG. 5, it seems that a satisfied fastening result occurs. However, this is provided that the fastening fore 310 from the clip can be ignored. If the fastening force 310 is considered, the stabilization plate 508 is still too thick. Note that the achievement wanted is to have stable contact of the thermal pad onto the die 300. The fastening force 310 from the clip should be considered and this consideration tells us that the most preferable thickness of the stabilization plate 508 is slightly smaller than that of the die 300. Nevertheless, the thickness of the stabilization plate 508 cannot be too small, since it would make the plate 508 has no contact with the chip under the die 300.

As for the choice of PORON, it is preferable because PORON can be easily sliced. On the other hand, PORON is quite soft and elastic. If PORON is pressedwith fingers, then fingerprints initially appear on the PORON, but will soon disappear.

FIG. 6 is a schematic, top view of an n-shaped PORON slice according to one preferred embodiment of this invention. Referring to FIG. 6, the left bar

608a and the right bar 608b of the n-shaped PORON slice respectively have a width of about 9.99 to about 10.01 millimeters. Above the two bars, the n-shaped PORON slice further comprises a lateral bar 608c having a length of about 48.69 millimeters to about 48.71 millimeters.

A heatproof test for the invented stabilization plate has been performed. In this test, the environment was heated to about 100 °C, and no stabilization plate reliability problem was found. (Generally, the temperature between a heatsink and a die would be up to only about 60-80°C).

To make one of ordinary skill more understand this invention, some tables showing experiment data are provided below herein. In table 1, except for the heatsink and the PORON slice, configuration of the tested hardware is substantially listed. In table 2, test results are shown. In this test, a T-type thermocouple is equipped to measure the temperature of the CPU. Recorder is YOKOGAWA/HR2300/Hybrid。

Table 1 SUT Configuration

CPU	2 X CPU (Power consumption 26.1 W)
Memory	4 X 1G
HDD	3 X 15000 rpm
FDD	Standard
CD-ROM	Standard
Power	200W
PCI Card	Mylex
Fan	2 X Blower (97x94x33)

Table 2 Test result

CPU T_j=70°C	CPU T_j (No PORON on the Heatsink)		Result	CPU T_j (PORON on the Heatsink)		Result
	CPU1	CPU2		CPU1	CPU2	
1	70.1	71.1	Fail	69.3	69.5	Pass
2	69.5	69.8	Fail	69.1	69.3	Pass
3	69.9	70.5	Fail	69.2	69.5	Pass
4	70.2	70.6	Fail	69.3	69.7	Pass
5	70.5	70.9	Fail	69.5	69.7	Pass

According to the test results, without a PORON slice, the temperature of the CPU is high and changes dramatically (69.5°C~70.5°C for CPU 1; 69.8°C~71.1°C for CPU 2). In the contrast, the temperature of the CPU is low and changes slightly (69.1°C~69.5°C for CPU 1;

69.3°C~69.7°C for CPU 2).

The present invention has at least the following advantages:

1. The invention provides enough contact between a thermal pad and a die.

2. In this invention, a heatsink absorbs heat through conduction more efficiently. Here, it is emphasized that the conduction plays an important role in heat transfer, even convection and radiation also contribute little to the heat transfer. Therefore, convection and radiation cannot cool a die well enough, if the heat conduction could not be performed efficiently. More precisely, the heat from a die is usually transferred to the heatsink through conduction. After the heat is transferred to the heatsink, convection, generated by a fan over the heatsink, excludes the heat on the heatsink. Here radiation is not critical and is therefore omitted.

3. In this invention, the PORON slice is elastic. Due to the elasticity, the clip would not easily shaken after the heatsink is fastened with the clip.

4. The invention prevents the heat density from being increased, since the heat density is usually increased by the defect contact between the die and the heatsink.

Although the invention has been described in detail herein with reference to its preferred embodiment, it is to be understood that this description is by way of example only, and is not to be interpreted in a limiting sense. It is to be further understood that numerous changes in the details of the embodiments of the invention, and additional embodiments of the invention, will be apparent, and may be made by, persons of ordinary skill in the art having reference to this description. It is considered that such changes and additional embodiments are within the spirit and true scope of the invention as claimed below.